and (C) the posterior molar, all of the left ramus of the mandible. In (B) and (C) can be seen the isthmus joining the roots of the molars and the traces of the original third root. The peculiar cusp-like pattern on the face of the teeth is also well shown.

It should be mentioned that the knob which is apparent in front of the nasal region of the skull in Fig. 1 is merely a concretion difficult to remove without damage to the skull.

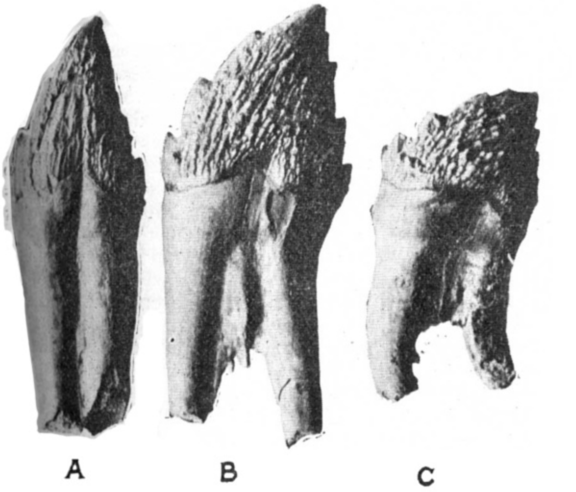

FIG. 2.

T. THOMSON FLYNN,
Ralston Professor of Biology.
University of Tasmania, Hobart, September 9.

The Energy of Cyclones.

I DO not find that people in general are aware of an important source of energy for the maintenance and intensification of cyclones, nor am I acquainted with a clear exposition by a meteorologist that the condensation of aqueous vapour will suffice.

Atmospheric pressure being a ton weight per square foot, the disappearance or collapse of a cubic foot of ordinary air would yield a foot-ton of work. The disappearance, by complete condensation, of the aqueous vapour in 760/12·7, say 60, cubic feet of atmosphere would yield the same amount.

If, then, the temperature of saturated air fell from 18° to 12° C. by reason of condensation and rainfall, so that the vapour-pressure diminished from 15·36 to 10·46 mm. of mercury, a foot-ton would be generated in each 155 cubic feet of that region of the atmosphere. Incidentally, the corresponding deposit of liquid would be 5 grams per cubic metre, or a rainfall of $\frac{1}{3}$ in. from a vertical mile of air.

Assuming that the above fall of temperature in the central region of a travelling cyclone is not excessive, the energy available in each cubic mile of it would be nearly a thousand million foot-tons.

OLIVER LODGE.

WITH reference to Mr. R. M. Deeley's letter on the above subject in NATURE of November 11, may I suggest that the energy of a cyclone is derived from the heat-energy of the earth's surface? If we assume that the air which ascends in the centre of the vortex is less dense on the whole than the air which is at the same temperature outside the vortex, then, since the ascending current must be compensated by a descending current elsewhere, the air will go through a thermodynamic cycle in which positive work will be done at the expense of the heat communicated at the earth's surface.

The process may be compared roughly to a Carnot's cycle, in which the inflowing air at the earth's surface is isothermally raised in temperature, expands adiabatically as it ascends, cools isothermally by radiation at the higher levels as it flows outwards, and contracts adiabatically in descending again. The work done would appear as increased vortical motion if the conditions were favourable, and the mechanical forces causing the motion would be due to the differences of hydrostatic pressure within and without the cyclone.

J. R. COTTER.
Trinity College, Dublin, November 13.

Molecular and Cosmical Magnetism.

RECENT researches on magnetism tend to suggest that the negative electron may be a magneton or unitary electromagnet as well as a unitary electric charge, consisting, that is, of an anchor-ring of negative electricity in rotation about its axis of symmetry. Such a magneton would behave mechanically like a gyroscope; magneto-gyroscopic effects have been previously considered and observed in relation to ferromagnetic bodies on the assumption that the ferromagnetism is due to electrons in orbital motion as a whole. Wider conclusions can be drawn, however, if the magneton hypothesis is adopted, and the deductions are of importance, not only in the theory of atomic and crystal structure, but also in relation to cosmical magnetism. The following notes describe a few of the more important consequences; a detailed account of the theory and of some experiments designed to test its validity will be published shortly.

A magneton rotating with any kind of matter will tend to align its axis parallel with the axis of rotation. Since the electricity of the magneton is negative, the direction of magnetisation will be related to that of rotation, as is the direction of translation to that of rotation in a left-handed screw. This is the right direction in order to account for the general magnetic fields of the earth and sun as due simply to their rotation. The explanation of the observed magnitudes of these fields seems to present no difficulty; numerical details will be given in the forthcoming paper, where also a theory will be suggested to account for the rapid radial diminution of intensity in the sun's general magnetic field.

Mr. S. J. Barnett has shown by delicate experiments on ferro-magnetic bodies that they become magnetised slightly on being rapidly rotated, and has propounded a theory according to which such bodies should acquire magnetisation of amount proportional to the angular velocity, the factor being a universal constant depending on the ratio (mass/charge) for an electron. The fields observed and calculated (on this theory) agree as to order of magnitude, but are quite inadequate to account for solar and terrestrial magnetism. The theory, however, apart from the fact that it is based on the hypothesis of electrons in orbital motion, seems to require serious modification.

On the present theory, magnetisation by rotation should be shown by dia- and para-magnetic bodies as well as by ferro-magnetic substances, and the intensity should be proportional to the angular velocity only when the substance is in such a state that the constraints exerted on the magneton by neighbouring nuclei and electrons are strictly elastic. In this case, moreover, the factor of proportionality will not be a universal constant, but will vary with the nature of the constraints, and in particular with temperature; in hot bodies the intensity of magnetisation should

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be greater than in cold ones. An extreme case is that in which the temperature is so high as to produce general dissociation of the electrons from the nuclei, as appears to occur in the interior of stars. Apart from the disturbance produced by collisions, the magnetons are then free to set their axes parallel to the axis of rotation, and a large proportion of them would seem to do this in certain cases (*vide infra*). The upper limit of magnetisation is reached when all the magnetons are set parallel to the axis; this limit can be calculated in some cases, it being possible to estimate the number of electrons in electrostatically neutral matter of given kind and density. Other things being equal, the maximum magnetisation will be proportional to the density and independent of the speed of rotation.

The magnetic fields of the earth and sun can thus be accounted for on the present theory because these bodies are at a high temperature (in the case of the earth this is so except for the parts near the surface); what has hitherto been an obstacle in framing theories of their magnetic fields is here regarded as probably the determining factor as regards magnitude.

The same explanation applies to sun-spots. These occur in pairs of opposite magnetic polarity, and it has been pointed out that the polarities are such as would be accounted for by negative electricity in rotatory motion such as is observed (with opposite directions) in the members of a sun-spot pair. The sun-spot pair is thus regarded as the surface portion of a "line"-vortex continuously connecting the ends beneath the surface. The difficulty has been that no Stark effect is observable, such as would accompany rotating charges of the required amount; it has therefore been suggested that the magnetism of sun-spots is due to galvanic currents, *i.e.* electrons in translatory motion through electrostatically neutral matter. This hypothesis is unnecessary; it seems possible to account for the observed fields, of order 3000 gauss, simply by the observed rotation of the matter composing the vortex, on the above magneton hypothesis.

The obliquity of the magnetic axes of the earth and sun requires some additional hypothesis for its explanation, since an unsymmetrical condition cannot be accounted for by a cause, like rotation, symmetrical about an axis. The obliquity being present, however, it seems possible to explain the secular variations of the solar and terrestrial magnetic fields as due to precessional motion of the magnetons. A magnetic field applied obliquely to a magneton will tend to cause it to precess round the lines of external magnetic force. The magnetic fields of the earth and sun, due mainly to rotation, will exert this effect on any magnetons the axes of which are inclined to them; the speed of precession depends solely on the strength of the applied field if the magnetons are free, and the direction of precession agrees with the direction of rotation of the magnetic axes of the earth and sun.

S. CHAPMAN.

The University, Manchester, November 13.

Physiological Effects of Alcohol.

DURING recent years a good deal of work has been done and a great many results have been published on the above subject. Some of these have been very recently reported in the general Press. In most, if not in all, of the researches which have been made on the physiological effects of moderate doses of alcohol, taken in the form of beer, spirits, or other alcoholic beverages, but little attention has been paid to the very important disturbing influence of what may be called "secondary products"—whether extractive matters normal to the beverages in question or volatile by-products of the alcoholic fermentation process itself. Most people are aware that there is no *definite* relationship between the intoxicating effects of certain wines and the amounts of alcohol which they contain, and the marked difference in the physiological effects of new whisky on one hand, and of well-matured spirit *of the same alcoholic strength* on the other, is a matter of common experience.

In the case of beer the soporific effect depends not a little on the hop and other extractives, and consequently there is no scientific justification for drawing any definite conclusions of a quantitative character as to the physiological effects of small doses of alcohol unless the beer used in the whole series of experiments had been of precisely the same character throughout, and even then the "personal equation" would introduce a further serious difficulty. Most beer-drinkers of middle age are well aware that the physiological effects of bitter beer on one hand, and of mild ale or lager (which are less heavily hopped) on the other, are not by any means the same, even for equal percentages of alcohol. The investigation of the effects of these various "secondary" constituents undoubtedly presents great experimental difficulties, but until their physiological significance is better understood there must always be an element of uncertainty in any conclusions arrived at in regard to the physiological effects of small doses of alcohol taken in the form of the usual alcoholic beverages.

A. CHASTON CHAPMAN.

London, November 15.

Atomic Structure.

THE arrangement of the non-nuclear electrons in the atom is being determined by work along two lines: first, from the Bohr-Sommerfeld theory of characteristic frequencies, and, secondly, from the Lewis-Langmuir or Born-Lande theory of the structure of molecules, supported by Prof. W. L. Bragg's work on atomic radii in crystals. It has been stated several times recently that the conclusions drawn from the two sources are mutually inconsistent, in that the first indicates that the electrons are revolving in planetary orbits, and the second that they are fixed in constant positions. The essential truth of the first theory is now beyond doubt; the second is extremely plausible. If they are really inconsistent the position would be intolerable.

But they are not really inconsistent. The Bohr-Sommerfeld theory does not make explicit use of the assumption that the electrons in their stable states are moving; it assumes only that in those states they have the energy, calculated by Hamiltonian (relativity) dynamics, which they would have if they were moving in certain orbits. It is not logically impossible to maintain that they have that energy and are yet at rest. Nor is it physically impossible if we accept Bohr's principle of "correspondence," which has been so astoundingly successful in explaining the Stark effect and in predicting the number of components in lines of the hydrogen and helium spectra. According to that principle, the intensity and polarisation of components can be predicted by the application of classical dynamics to certain assumed orbits, although it must be assumed at the same time that the electrons are *not* moving in those orbits. If intensity and polarisation can be predicted from orbits that are wholly fictitious, why not energy?

Of course, the adoption of Bohr's principle in this extreme form would sever the last connection between classical dynamics and the real structure of the atom. But we are surely now all convinced that we must abandon part of that connection. Is there any reason

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